CORRELATION ENERGIES BY THE PROJECTED GENERATOR COORDINATE METHOD

M. Bender, G. F. Bertsch
Institute for Nuclear Theory, University of Washington, Seattle, USA
P.-H. Heenen
Service de Physique Nucléaire Théorique, Université Libre de Bruxelles, Belgium

Self-consistent mean-field approaches are a useful tool to describe many phenomena in low-energy nuclear structure physics [1]. Nowadays, these models have reached a precision where certain correlations have to be taken into account for further improvement. In the language of the spherical nuclear shell model, mean-field states incorporate particle-particle (pairing) correlations as well as many-particle-many-hole correlations, the latter by allowing for a deformation of the nucleus in the intrinsic frame. As a consequence, however, mean-field states break several symmetries of the exact many-body states. The broken symmetries can be restored by projection, for example broken rotational symmetry by angular-momentum projection. Additional correlations can be added when performing configuration mixing of projected mean-field states. For example, the mixing of mean-field states with different quadrupole moment removes spurious quadrupole vibrations from the ground state, and at the same time gives the excitation spectrum. The method can be implemented for the Skyrme-Hartree-Fock-Bogoliubov approach, using the full model space of occupied single-particle states. The method allows the calculation of collective excitation spectra throughout the chart of nuclei from ^{16}O up to the heaviest nuclei [2].

Projection and configuration mixing add a few MeV of correlation energy to the ground-state binding energy. We invesigate the quadrupole correlation energy within the framework of configuration mixing of particle-number and angular-momentum projected self-consistent mean field states. The correlation energies are calculated within a GOA scheme proposed in Ref. [3], where the GOA is used as a numerical tool to obtain a very efficient calculation of the rotation in the angular-momentum projection and to calculate the matrix of overlaps needed to solve the Hill-Wheeler equation for the ground state.

We present the general ideas of the method and the approximations used, numerical tests of the method, and results of a large-scale investigation of the correlation energy for the even-even nuclei for which the mass is known. The correlation energy is different for spherical magic, transitional, and well-deformed nuclei, which affects the systematics of calculated binding energies, in particular in the vicinity of magic numbers.

[1] M. Bender, P.-H. Heenen, P.-G. Reinhard, Rev. Mod. Phys. **75**, 121 (2003).
[2] M. Bender and P.-H. Heenen, Nucl. Phys. **A713**, 390 (2003);
T. Duguet, M. Bender, P. Bonche, P.-H. Heenen, Phys. Lett. **B559**, 201 (2003);
M. Bender, H. Flocard and P.-H. Heenen, Phys. Rev. C **68**, 044321 (2003);
M. Bender, P. Bonche, T. Duguet, P.-H. Heenen, *Configuration mixing of angular momentum projected self-consistent mean-field states for neutron-deficient Pb isotopes*, Phys. Rev. C. (in press). preprint nucl-th/0311090;
M. Bender, P. Bonche, P.-H. Heenen, *Microscopic study of ^{240}Pu: mean field and beyond*, (in preparation).
[3] M. Bender, G. F. Bertsch, P.-H. Heenen, Phys. Rev. C **69** (in press).